The Gulf of Khambhat debate from 2001 to 2024: Technology versus history or Science versus archaeology?

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The Gulf of Khambhat debate started in 2001 continued in 2024: NIOT during its geological studies conducted underwater survey at the Gulf of Khambhat (Cambay) with the underwater instruments found characteristic pattern of systematic arrangement for kms distance. Samples were also collected through instruments and sent for testing. They gave dating to 9500 YBP. When reported that it could be a submerged city with the material objects recovered were dated to 9500 BCE, there was a mixed response. While the researchers with science and technology background appreciated, notably, the media came down heavily criticizing. It even carried the opinion of leading archaeologists to cast aspersion on the objects recovered and the theory proposed. After 23 years, in 2024, the issues were discussed again adding the view of the archaeologist Justin Morris from the British Museum. Therefore, the background and the problems involved are discussed now, as most of the researchers might have forgotten the issue..

2000 – NIOT survey started[1]: The National Institute of Ocean Technology (NIOT), the technical arm of the Department of Ocean Development, Government of India, was carrying out several off-shore surveys for various purposes including pollution monitoring, harbour engineering, pipeline laying, construction of offshore structures, etc. In 2000, during the course of surveys conducted in the Gulf of Cambay, NIOT recognized a series of geometric patterns on the sea bed picked up by side-scan sonar soundings which are very unusual in the marine domain. Repeated surveys of these features clearly picked up a palaeochannel-like feature over 9 km long. In order to substantiate these findings, NIOT carried out detailed sub-bottom profiling in the area. The features occurred at depths of between 20 and 40 m in the Gulf of Cambay about 20 km west of Hazira. There are no known references in the literature to this site[2]. This discovery was made by analysis of advanced underwater sensors like side-scan sonar, sub-bottom profiler and multi-beam echo sounder. Here the experts presented some aspects of this marine archaeological discovery. The details (published in the paper) are reproduced here for convenience and discussion.

[1] S. Kathiroli, S. Badrinarayanan, D. V. Rao, B. Sasisekaran, and K. M. Sivakolundu, ***New Archaeological sites in the Gulf of Cambay, India***, Episodes Journal of International Geoscience, 26(1), March 2003, pp.16-18.

[2] For the discovery of the submerged Dwaraka, there have been ancient literary evidences and tradition recorded in the later literature also. S. R. Rao has given such references in his papers and books published.

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Geological setting: The Gulf of Cambay is located in the southwestern part of the State of Gujarat, and is an arm of the Arabian Sea, covering over 3,000 sq km. Several rivers, including the Narmada, Tapti, Sabarmati and Mahi, drain into it. Almost all the rivers have preferred directions of NE-SW, ENE-WSW or NNE-SSW. These rivers form an estuarine complex. In the Gulf of Cambay, there are several long linear sandy shoals which rise predominantly from the surrounding clayey formations. These shoals are known to shift their locations periodically and cause uncertainties in the sea bed bathymetry and hence for navigation. An examination of the earlier topo-sheets with the later National Hydrographic Charts and the LANDSAT imageries indicates the growth of landforms like bars, levees, mud flats, islands, etc. The area has three major faults (Merh and Chamyal[3], 1997), designated as the Cambay graben fault trending in a N-S direction, west coast fault along NNW-SSE direction on the east coast and the approximately EW-trending Narmada geofracture.

Tectonic effects: Neotectonic activity in this region appears to have disrupted river courses from time to time. The area experiences periodic earthquakes and tremors, and scrutiny of them reveals that the surrounding areas like Bharuch, Bhavnagar, Surat, Dumas, etc., are often the epicenters of these seismic events. This being a well-known macro-tidal regime with a tidal range of 12.5 m and with a current speed of up to 8 knots, turns the sea state from rough to very rough. Due to these factors, the waters of the Gulf of Cambay are heavily silted, brownish in colour and highly turbid. Such conditions impose severe restrictions on surveys and the understanding of the geology of the area. The Cambay Sea extends over 80 km in width between Gopnath point (21˚11'8"N 72˚06'37"E) in the west and Hazira (21˚4' 35"N 72˚37'31"E) on the east coast. Thus, the usage of scientific equipments necessitated in the context was pointed out.

NIOT collected samples: The detailed survey by NIOT revealed that the Gulf of Cambay has an alternating sand and clay formation on the seabed. In order to understand the occurrence of the palaeo-channel in the middle of the Gulf of Cambay, some cores were taken by vibro- and gravity-coring operations. These revealed that in the palaeo-channel area the sea bed surface and a section up to about 0.7 m depth is made up of medium sand with marine shells representing marine-facies. This is followed, at depths of 0.70 to 2.20 m, by a sand and silt formation containing freshwater shells representing alluvial facies (fluvial regime) and archaeological material. At this depth there is a sharp contact with pebbly conglomerate representing fluvial-facies lying below. As one goes deeper, a sharp contact with calcareous sandstones with rhizoliths is found at depths varying from 3 to 4 m. The last one represents buried land surface. Several of the calcareous sandstone samples collected had regular circular or rectangular perforations. A thin section study of these under the petrological microscope shows that well-rounded goethite grains constitute about 25% of the material, with sizes ranging from 80 to 110 microns.

[3] Merh, S. S., and Chamyal, L. S., 1997, ***Quaternary Geology of Gujarat Alluvial Plain***, Proceedings of the Indian National Science Academy, 63 A, no.1, pp. 1-98.

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Nature of the earth / stone samples: About an equal percentage of the detrital grains seems to be angular to sub-angular quartz with a size range of 40 to 60 microns. The remaining cementing material is mostly made up of calcite. Apart from this, a few foraminifera, textularids, sponges, echnoid spicules and few ostrocod skeletal remains are found. The rock apparently represents a fluvio-marine environment which subsequently became water-cemented probably due to the lowering of the ground water level in the area. This is evidenced by the formation of root casts and rhizoliths. The calcareous sandstone indicates an ancient land surface on which fluvial and human activities took place. The conglomerate mainly consists of basalt, chalcedony and litho-clasts of calcareous sandstone, and represents a high-energy fluvial system. Similar conglomerates were observed below the early Harappan settlement at Padri on land on the western side of the Gulf of Cambay. Thus, the conglomerates formed at the Khambhat underwater and that of the early Harappan settlement at Padri on land near to Cambay were compared. Thus, the Khambhat is dated prior to Harappan.

Archaeological findings: The side-scan sonar images have picked up rectangular basements like feature on either side of the palaeochannel with a relief of 2 to 3 m from the seabed and vary in size from 5 × 5 m^2 to as much as 15 × 15 m^2. These features are often covered by sand waves. At places basements of possibly major structures have been picked up. The sub-bottom profiler survey clearly revealed successive layers made up of foundation-like features and cultural strata indicated by acoustic impedance contrast below the basement. The sites identified by side-scan survey were subjected to sampling by a Van-Veen grab sampler[4], dredge sampler, and by gravity and vibro corers. Quite a few artefacts of archaeological importance have been recovered from these sites, which are absent outside the area adjoining the palaeochannel. In other words, the recovered samples were reportedly found at the site that was assumed to be the settlement area.

Artefacts found: The artefacts identified included many beads, of which a broken barrel-shaped bead of chert (measuring 13 mm in length and 6 mm in width and with a 4 mm diameter hole, is important. As per A. Gosh[5], the tradition of making beads is at least 7000 years old. A chert blade scraper, measuring 76 mm in length, with a width varying from 35 mm to 19 mm and with a thickness of 10 mm, typologically belonging to the upper Paleolithic cultural tradition, was also recovered. Low-fired and grass-embedded pottery pieces were recovered, along with broken hearth material. The piece appears to be made of fine, well levigated clay and is about 3 mm across. The perforated stone piece was examined under an optical image analyzer. The examination revealed, in 100 X magnification, that the holes are irregularly oval in shape and have varying contours. This appears to be connected with deliberate boring activity by a stone tool like a borer, which was quite common in the prehistoric period. In addition, quite a few human bones, as well as a few teeth, have been recovered from the area. These artifacts

[4] The Van Veen grab sampler is an instrument to sample sediment in water environments. Usually it is a clamshell bucket made of stainless steel. Up to 20 cm deep samples of roughly 0.1 m2 can be extracted with this instrument. It can be light-weight (roughly 5 kg) and low-tech. The smallest version even fits into hand luggage. The sampler was invented by Johan van Veen (a Dutch engineer) in 1933.

[5] Gosh, A., 1989, ***Encyclopaedia of Indian Archaeology***, Munshiram Manoharlal, New Delhi, pp. 39, 216.

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mentioned were only questioned by the archaeologists reported through the "Frontline." However, the magazine did not publish any opinion or the response of the NIOT scientists and technical experts.

January 2002 - An underwater urban settlement that pre-dated the Harappan civilisation had been discovered in the Gulf of Khambhat: On January 16, 2002, Union Minister for Human Resource Development, and Science and Technology, Dr. Murli Manohar Joshi, who held additional charge of the Department of Ocean Development, made a sensational announcement at a press conference in New Delhi[6]. He claimed that an underwater urban settlement that pre-dated the Harappan civilisation had been discovered in the Gulf of Khambhat, off the coast of Gujarat[7]. The spin and interpretation given by Dr. Joshi to the Gulf of Khambhat findings by scientists of the National Institute of Ocean Technology (NIOT) generated criticism by, and objections from, Indian and foreign archaeologists, scientists and historians (Frontline, March 15, 2002). Most experts agreed that the claims were made by Dr. Joshi with a view to politicizing the issue and that more exploratory work needed to be undertaken before any meaningful analysis of the findings, leave alone interpretations, could be made. Thus, the media had swung to criticize with such strong words. Particularly, the "Frontline," known for its Marxist ideology, initiated such bombarding tirade against the discovery. The names of the scientists or historians were not revealed by the "Frontline."

Prof Dr Murali Manohar Joshi – an expert in Spectroscopy and Nuclear Physics: The way the media, particularly, the Marxist Frontline used such expression against him, suppressed that he has been an expert in Spectroscopy and Nuclear physics. He studied B.Sc. Physics from Meerut College and M.Sc. from Allahabad University. He began his career in the University of Allahabad after obtaining a Ph.D. in Physics (Spectroscopy) with specialization in the nuclear physics, at the young age of twenty-three in 1971 and superannuated as Professor and Head of the Physics Department in 1994. He stated his teaching career as a temporary lecturer in 1956, appointed as reader in 1972 and professor in 1984. 13 scholars worked under him to get PhDs and one D.Sc in physics. Therefore, it is irony that the Indian media and journalists could not understand the personalities with their academic excellence, but, criticize with their biased political and other ideologies. They could not appreciate that the most suitable academician had been a minister for "Ocean Development," instead of a mere politician without any qualification or knowledge of the subject matter dealt with. The unknown scientists or historians also did not bother about his standard, status and capacity.

The questioning experts would be knowing the science and technology: with the correlative, collaborative, contemporary and corresponding evidences, if recovered objects are compared and matched and the datings also come to near them, then such result / conclusions may be accepted. That is nowadays, most of the findings are dated accordingly and decided conclusively. The real underwater exploration and excavation

[6] Frontline, ***The Gulf of Khambhat debate***, Published : Mar 30, 2002 00:00 IST.
[7] https://frontline.thehindu.com/the-nation/article30244516.ece

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could be possible and carried on by man, only up to certain depth withstanding pressure, temperature, turbidity, visibility, threat of oceanic species and animals etc. thus, for danger-prone areas, only marine equipments and instruments are used to play the role of human beings to carry out such exploration and excavation activities. When Satellite and remote sensing techniques are used in the land-archaeology, there could not be any objection to use such techniques for underwater marine archaeology. Yet, the experts could not appreciate such scientific necessity and technical exigency.

Experts to be consulted about the dating: the "Frontline" proceeded to assert that "Experts felt that internationally reputed marine archaeologists, scientists and archaeologists working on India and on the Neolithic Age needed to be consulted on the methodology of further exploration, dating and analyses." Well-known experts on South Asian archaeology, like Richard H. Meadow of Harvard University, even offered to help in such an effort. Experts raised several objections to Dr. Joshi's claim that NIOT had discovered the remains of a 9,500-year-old urban settlement and civilisation.

1. First, no marine archaeologist has seen the site and no mapping or underwater photography of the site has been undertaken.
2. Secondly, the dating of the site was attempted on the basis of the age of a piece of wood found there.
3. Thirdly, there was no conclusive proof that the perforations found in the artefacts were man-made.
4. And, fourthly, there were deviations from the standard, accepted procedures of archaeology prior to going public with the findings.

This type of arguments can easily be made with the excavated objects also, as they were handled by the excavators, researchers and others at the site, till some of them or the associated sample are sent to laboratories for dating. However, technically, here all questions were answered already in the NIOT reports and the published papers. perhaps, they could not have read them properly or chosen to raise such questions, just to suit the media persons who interviewed them. Here, it has to be noted that only one side view was projected, without contacting the scientists who actually conducted and involved in the scientific surveys with technical instruments.

In 2024 – how the discovery is narrated: Now in October 2024, one Harriet Brewis raised this issue. The vestiges of what many believe to be a lost, ancient civilisation have been discovered off the coast of western India. What has been described as a vast city, stretching more than five miles (8km) long and two miles (3km) wide, was discovered 36 metres (120 feet) underwater in the Gulf of Khambhat (previously known as the Gulf of Cambay)[8]. The most exciting part of the discovery, which was made by the National Institute of Ocean Technology (NIOT) back in December 2000, is that it could rewrite human history as we know it[9]. However, more

[8] Indy.100, ***Lost underwater 'city' discovered in India could rewrite the history of civilization***, Harriet Brewis, Oct 18, 2024.

[9] https://www.indy100.com/science-tech/lost-civilization-india-harappan-2669439780#:~:text=And%20indeed%2C%20other%20experts%20have,grid%20pattern%2C%E2%80%9D%20he%20said.

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than two decades since the landmark find, experts are still at loggerheads over the age and significance of the archaeological site, which has come to be known as the Gulf of Khambhat Cultural Complex (GKCC).

Using sonar technology, the team identified huge geometrical structures deep down on the seafloor: So what the archaeologists or historians object to? The city-like structures were uncovered by NIOT by chance, as they performed routine pollution surveys in the region. Using sonar technology, the team identified huge geometrical structures deep down on the seafloor. Debris recovered from the site included pottery, beads, sculptures, sections of walls and human bones and teeth, with carbon dating finding these to be nearly 9,500 years old, BBC News reported at the time[10]. Announcing the discovery on 19 May 2001, India's then science and technology minister, Murli Manohar Joshi, said that the ruins belonged to an ancient civilisation[11]. Dr Joshi said this would have been even older than the Bronze Age Indus Valley civilisation (also known as the Harappan) – the hitherto earliest known urban culture of the Indian subcontinent and one of the world's three earliest civilisations, along with Mesopotamia and ancient Egypt. In other words, this discovery looked set to have massive repercussions on the view of the ancient world.

NIOT chief geologist clarified: S. Badrinaryanan, who was chief geologist for NIOT's scientific team at the time, wrote in a piece for Archaeology Online[12]: "For decades archaeologists have argued about the origins of the mysterious 'Harappan' (Indus Valley) civilisation that flourished across what is now Pakistan and northwest India from about 3000 BCE. "Now, [our new findings] suggest that the Harappans were descended from an advanced mother culture that flourished at the end of the last Ice Age that was then submerged by rising sea levels before 'history' began." He went on: "It was generally believed that a well-organized civilization could not have existed prior to 5500 [before the present day]. Many were reluctant to accept that the flood myths mentioned in many ancient religious writings held some grains of truth." Thus, here, the scientist had taken the criticism also into account.

NIOT geologist gave scientific explanation: However, he insisted, that the discovery made by his colleagues and him "clearly established the existence of an ancient civilisation that was submerged in the sea." And yet, he said, "conservative archaeologists found it hard to accept" that modern scientific techniques had succeeded in making such a major discovery. "Initially, when the sidescan sonar images of underwater structures were shown, some called it a magic of computer software," Badrinarayanan recalled. "When hundreds of artefacts were collected and shown, they opined that the ancient river could have transported it!" Stressing the rigour of his

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[10] BBC, ***Lost city 'could rewrite history'***, Saturday, 19 January, 2002, 06:33 GMT; http://news.bbc.co.uk/2/hi/south_asia/1768109.stm

[11] PIB, ***Major Archeological Discovery in Gulf of Cambay***, May 19, 2001https://archive.pib.gov.in/archive/releases98/lyr2001/rmay2001/19052001/r190520011.html

[12] B. Badrinarayanan, ***Gulf of Cambay: Cradle of Ancient Civilization***, https://www.archaeologyonline.net/artifacts/cambay-:~:text=The%20artifacts%20collected%20included%20a,human%20remains%20and%20human%20teeth.

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team's work, he continued: "Detailed scientific studies were undertaken to prove that the artefacts are in situ. "The criticism has driven us to adopt the most modern technologies and scientific methodologies available in the world, which have completely substantiated our findings, and the results have been published as research papers in reputed international journals."

2002 - Iravatham Mahadevan, acknowledged that the sonar photos revealed structures that were most likely built by men: And indeed, other experts have validated at least some of the conclusions drawn. Speaking to Frontline in 2002[13], Indian civil servant and the country's leading expert on the ancient Indus script, Iravatham Mahadevan, acknowledged that the sonar photos revealed structures that were most likely built by men. So as an expert, he responded carefully understanding the technology behind. "First, there are a series of squares which [Badrinaryanan and his fellow scientists] interpret as a settlement in a grid pattern," he said. "I am not an archaeologist, much less an underwater archaeologist," he conceded, but still: "It is very difficult to imagine a series of square plinth areas, with grid-like structures, running for several kilometres, occurring in nature." And, he continued: "Again, there is a long rectangular structure with something similar to steps leading downward, which is clearly man-made." And yet, when it comes to many of the artefacts, including precious stones, Mahadevan and others agree that these could have "washed in" from elsewhere. Perhaps the most contentious piece of "evidence" takes the form of a single piece of wood. This wood was carbon dated to an age of 9,500 years – which many experts used to establish the age of the entire site. Thus, it is evident that he had read the NIOT reports and papers, so that he responded with professional decency, academic decorum and scholarly ethics.

March 2002 - Asko Parpola raised questions about the artifacts recovered: And yet, another Indus specialist – Asko Parpola of the University of Helsinki – pointed out that key questions needed to be asked here. In a separate interview with Frontline[14], he said:

1. "First, can the age of the wood found under the sea be correlated to the antiquity of the site?
2. "Secondly, is this one piece of evidence enough to conclude the antiquity of the site?
3. "Thirdly, is the underwater site a secure context to gauge the antiquity of the site?"

He then asked: "Can radio carbon dating (that is used in this case) and thermoluminescence (that is to be used for pottery found at the site) give reliable dating for ancient periods?" He then conceded: "I have seen some interesting materials that seem to occur only in this place; not in the surrounding areas. But the problem with this site is that there is very heavy tidal influence and the sands are shifting all the time. "So when we find flat objects here it seems to me perfectly possible that this flattening is done by sand activity - erosion by the sand. "Even the holes that we found in the stones

[13] Frontline, ***'Be sceptical, and not negative and destructive'***, Published : Mar 30, 2002 00:00 IST;
https://frontline.thehindu.com/the-nation/article30244518.ece
[14] Frontline, ***The Gulf of Khambat debate***, Published : Mar 30, 2002 00:00 IST ;
https://frontline.thehindu.com/the-nation/article30244516.ece

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got from this area may not be due to human drilling. A flat object could have been stuck on a stone and started rolling around because of water activity (currents). So, these holes may have occurred naturally." So he picked up technical glitch to raise such objections to suit the media trial.

2002 - Graham Hancock supported the discovery: And yet, despite the skepticism of the likes of Parpola and Mahadevan, many enthusiasts have jumped on the discovery with great excitement, thus continued Frontline. Controversial film-maker Graham Hancock insisted to BBC News that the evidence was compelling: "The [oceanographers] found that they were dealing with two large blocks of apparently manmade structures," he said. "Cities on this scale are not known in the archaeological record until roughly 4,500 years ago when the first big cities begin to appear in Mesopotamia."Nothing else on the scale of the underwater cities of Cambay is known. The first cities of the historical period are as far away from these cities as we are today from the pyramids of Egypt." This, he stressed, could cause massive disruption to our current historical timelines. "There's a huge chronological problem in this discovery," he said. "It means that the whole model of the origins of civilisation with which archaeologists have been working will have to be remade from scratch."

2024 - Archaeologist Justin Morris from the British Museum responded after 23 years: Nevertheless, archaeologist Justin Morris[15] from the British Museum said much more work was needed before the site could be categorically classified as belonging to a 9,000-year-old community. "Culturally speaking, in that part of the world there were no civilisations prior to about 2,500 BCE. What's happening before then mainly consisted of small, village settlements," he also told BBC News. Morris also pointed out that the C14 carbon dating process used to establish the age of many of the site's artefacts is not without its fallibility. Still, 23 years after the discovery was made, a firm conclusion has yet to be reached. This is partly because exploring the site is very difficult owing to its location in highly treacherous waters, with strong currents and rip tides. And yet, Joshi and others have insisted that the truth must be established. "We have to find out what happened then," he said. "Where and how this civilisation vanished." But, here in India, who cares for such research is not known.

Limitations of archaeology[16]: Archaeology has limitations because of the nature of the archaeological record (sediment formation), the way it is formed (subjected to climatic, geological and man-made disturbances), and the subjectivity of interpretation (tainted with politics, ideology and funding agencies).

- Archaeology is not a science or exact scientific subject, though, instruments of science and technology are used. Like science, no two archaeologists could arrive

[15] With over 20 years of experience working at two of the most well-known museums in the UK and a lifetime love of the natural world, Justin Morris joined the Bristol Zoological Society in June 2018. With Morris at the helm, the 186-year-old Bristol Zoological Society has undergone a significant organisational transformation. By leaving its original home city site and investing in a much larger countryside site, the organisation has created a modern zoo that will be suitable for the next 150 years or more.

[16] Google AI generated and developed further with teaching and practical experience in the Indian context.

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at the same result, though they dig at the same site with the same recovered objects. Historians also assert that they need not have any objectivity[17].

- Archaeologists find embedded objects by luck, even after digging, as they were left by chance only. The sites are created by the left out objects and all the left-out objects may not form part and parcel of the dug-site.
- Only part of the left-out objects are recovered, that too, part of the vast area, where the authors of the left-out supposedly lived and left.
- Many times, the uncomfortable objects are left out, ignored or even suppressed, as they are not helpful to their studies, but also conflict with their interpretation to arrive at their desired conclusion.

Different types of limitations involved: Limitations of the archaeological record

- **Loss of information**: Artifacts can decay or be lost, and the relationships between them can change over time (climatic changes etc).
- **Incomplete evidence**: Evidence may be randomly acquired and destroyed before discovery (due to continuous infrastructure development activities carried on).
- **Subjectivity[18]**: Interpretation of data is subjective (well-known – In India, as the academicians have already been divided based on politics, language, region and s on).
- **Conflicting evidence**: Evidence may conflict with other finds.

Limitations of archaeological interpretation

- **Language**: Some languages cannot be deciphered (IVC).
- **Hoaxes**: Hoaxes have occurred in archaeological investigations.
- **Normal life**: Normal life activities like renovations and destruction of homes can eliminate material remains.

Other limitations

- **Poor techniques**: Poor excavating techniques can lead to destruction.
- **Analogy**: The use of analogy can be a problem[19].

Despite these limitations, archaeology can help us understand the past, preserve cultural heritage, and learn about human behavior.

Scientific temper and technological disposition: Nowadays, the historians very often talk about the "scientific temper" to be applied in their historical interpretations, historiographical narratives and historiosophical discourses. But, they also lose their temper, when they claim that they do not require any objectivity in their historical arguments. Therefore, what temper, mood or humour, they require has to be analyzed technically, scientifically or otherwise.

- Similarly, the archaeologists depend upon the science and technology, instruments, equipments and gadgets.

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[17] Kohl, Philip L. "***Limits to a post-processual archaeology (or, The dangers of a new scholasticism)***." *Archaeological Theory: who sets the agenda* (1993): 13-19.

[18] Brandfon, Fredric. "***The Limits of Evidence: Archaeology and Objectivity***." *Maarav* 4.1 (1987): 5-43.
In the western context, the "Biblical archaeology" is discussed, but in India, ideology works with regionalism, linguistic nationalism, and related factors.

[19] Goggin, John M. "***Underwater archaeology: its nature and limitations***." *American Antiquity* 25.3 (1960): 348-354.

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- They (the instruments etc.,) go on get developed, changed and updated with the advancement of technology. Therefore, getting tested results only, they too start their interpretations.
- The test lab experts give their results with many limitations and warnings, just like a pharmaceutical company that gives "side effects".
- Therefore, using science and technology, they cannot ignore such limitations and declare finally, about the dating of their objects excavated, handled and transported to the labs.
- If academicians want to criticize other academicians, definitely, it is possible by the expertise ones, with their experience.
- As they worked and experienced at different levels, with their 40 to 60 years of experience, they could easily find out the loopholes.
- But, here one should not resort to belittle the scientific expertise with assumed ambiguity or hypothetical excuses.
- Definitely, the persons with the scientific and technical background, years of experience and equanimity would be judicious and balanced in airing their views.

In the context of application of science and technology, the questioning of processual archaeology also arises.

Processual or New archaeology[20]: Processual archaeology is a scientific approach to studying human culture in the past. It's also known as New Archaeology.

How it works

- Processual archaeologists use scientific methods to test hypotheses and theories.
- They use models and theories about social, cultural, and natural processes to explain how human behavior changed in the past.
- They try to find general rules that explain why people in different parts of the world have similar cultural practices.

Why it's important

- Processual archaeology helps us understand how and why past human societies changed over time.
- It helps us understand the social, cultural, and political processes that shaped past societies.

Who is associated with processual archaeology?

- Lewis Binford is considered the father of processual archaeology. He was one of the most influential archaeologists of the 20th century.

Related archaeological theories

- Post-processual archaeology is an opposing archaeological theory that emphasizes the subjectivity of archaeological interpretations.
- Experimental archaeology is an approach that helps archaeologists bridge the gap between the past and the present.

However, it can easily be noted that as man had / has been progressing and using advanced appliances, gadgets and devices during the course of time and they had / have also been changing with science and technology, they are to be understood in the context at time and place carefully in the archaeological context.

[20] Google-AI generated and used for the comparative study in the Indian context.

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Some of the traditional domestic appliances used in kitchen[21] in the context of archaeology: In India, with the population rise with the usage of advanced science and technology, more than 50% population has been still using the traditional appliances, transport and other essentials for livelihood.

Some of the main domestic appliances used in the Indian kitchens for thousands of years are discussed in the context. Varieties of them have been discovered during the excavations from the Paleolithic period onwards. Therefore, man had been having such expertise to process and cook food. They are mentioned as follows:

- உரல் / Khal Dasta = Ural - mortar and pestle (mortar – horizontal movement or rotation), used to crush ginger, garlic, cardamom, pepper, chillies etc.
- அம்மிக்கல் = ammikkal (Sil Bhatta, stone rotating vertically), commonly used even today for grinding chutney, spices and vegetable pastes / gravies of all varieties;
- கல்வம் (Kalvam) = similar to grinding stone, specifically used for grinding herbs and Ayurvedic medicine;
- ஆட்டுக்கல் / ஆட்டுரல் = grinding stone – bigger version of Ural, used for grinding vegetable ingredients;
- உராய்கல் = grinding stone, for pounding rice, cereals, dhal and other grains etc.,
- ஜல்லடை = siever, used for sifting particles and get finer grains; the bigger grains are ground again and sieved;
- உலக்கை (Paddy / rice pounder), made of wood with the metal strip covered bottom, so that it is used to pound grains and put in a bigger jar;
- கல்சட்டி = a stone vessel; container made of a stone that is used to store pickles etc., for about one year with lid;,
- அகப்பை = coconut wooden ladle, made of a stick inserted into a half broken coconut shell'

Now, though, these have been replaced with the modern domestic appliances, there is no basic difference in usage. The stone still forms the part and parcel of the Domestic Electrical / Electronic appliances, whether there are one or more stones rotating vertically or horizontally or both, depending upon the design. With all these modernized set-up, modular kitchen etc., food is ordered and eaten. The other related issues can also be discussed.

Conclusion: In view of the above, the following points have to be considered in the archaeological context, to come to any conclusion:

- Even in the archaeological subject also, with the modern verbose, more subjects like archaeography, archaeometry, archaeosophy, archaeo-philosophy, archaeo-epistemology, archaeo-phobia etc., can be formulated for further studies.

[21] K. V. Ramakrishna Rao, ***Revitalizing Indian Knowledge Systems: Bridging History and Technology***, A paper presented during the Seminar on the " Revitalizing Indian Knowledge Systems: Bridging History and Technology" - January 23rd and 24th, 2025 at Chennai.

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- Just like historical studies, it can also lead to philosophical enigma diluting scientific reality. Speaking scientific language and technological instruments, archaeologists cannot escape with their objectivity.
- From Paleolithic to prehistoric to protohistoric to historic, how man exactly get modernized, has to be decided chronologically and such data used for a particular region, nation or country.
- If excavations are carried in discovering stone tools, potsherds, broken pottery, bones and skulls of men and animals again and again, no standard theory is established. They would be found so during the early periods, normally at any site.
- The lithic to metallic transition is also not standardized and therefore, it has to be standardized. In one nation or country, the same people at that particular period cannot be found to be following different cultures with archaeological evidences recovered.
- River based civilizations were studied and for the dead civilizations, instead of science, subjective hypotheses, ideologized theories and dogmatic laws are imposed.
- Settled people move from place to place for natural catastrophes and man-made calamities. Archeologists have to use satellite, remote sensing and other scientific methods to analyze how they happened.
- Disposal of waste was done in a natural way (till modern period) and therefore, only objects of imperishable and useless nature were left out for degradation in due course.
- The potteries were of brittle and disposable nature and therefore, they were thrown away, the moment they were broken or used up. Thus, they are to be discovered again and again.
- The metallic ware were recyclable nature and thus there were remelt and used. Here also the metallic articles, which were of the perishable nature due to rusting, oxidation etc., were disposed off after usage.
- Habitation and burial sites cannot be confused with habitation sites of meat eating and cremation practicing people. Killing has to be differentiated clearly either for eating or ritual; death by nature, accident, disease etc., also taken into account.
- The ash, slag and waste of metallic and non-metallic objects have also to be identified, recognized and treated archaeologically. All ashes cannot be treated as same, so also slags and wastes dumped.

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